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# मानक

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IS 7902 (2001): Aluminium alloy forging stock and forgings for aircraft purposes (Alloy 24345) [MTD 7: Light Metals and their Alloys]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



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भारतीय मानक

वायुआकाशीय अनुप्रयोगों हेतु ऐल्युमीनियम धातुओं से बनी  
फोर्जिंग स्टॉक एवं फोर्जिंग (मिश्र धातु 24345) — विशिष्टि  
( पहला पुनरीक्षण )

*Indian Standard*

ALUMINIUM ALLOY FORGING STOCK AND  
FORGINGS (ALLOY 24345) FOR AEROSPACE  
APPLICATIONS — SPECIFICATION  
( *First Revision* )

ICS 49.025.15; 77.120.10

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**BUREAU OF INDIAN STANDARDS**  
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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by Light Metals and Their Alloys Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1975. While reviewing this standard in light of experience gained during these years, the Sectional Committee decided to revise the standard.

Forgings of Al-Cu-Mg-Si-Mn alloy are widely used for aircraft structural fittings and components. This standard is prepared to specify the requirements for forgings stock and forgings.

In this revision, the alloy composition, mechanical properties have been rationalized and generally brought in par with following International Aerospace Specifications, while keeping in view indigenous manufacturing practices.

|                       |  |
|-----------------------|--|
| AU4SG(IGC. 04-32-044) | Standard extrusions bars — Sud Aviation. (French specification).   |
| BS 2L 77 : 1971       | Specification for forgings stock and forgings of aluminium-copper-magnesium-silicon-manganese alloy (solution treated and precipitation treated). British Standards Institution. |
| Gost 4784 : 1974      | Wrought aluminium and aluminium alloy. Grade-AK8 (Russian specification).  |
| QQ-A-367H             | Aluminium alloy forgings (Alloy 2014). Federal Specification USA.  |
| AIR 9051A             | General acceptance requirements of semi-finished products in aluminium alloys for forgings.  |
| AFNOR A7-4SG (2014)   | Ministry of Defence. France.   |
| WL 3.1254             | Teil 1 (May 1988) Aerospace : Wrought aluminium alloy 4.5 Cu - 0.9 Si - 0.8 Mn - 0.5 Mg (hand forgings). German standards.   |

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## *Indian Standard*

# ALUMINIUM ALLOY FORGING STOCK AND FORGINGS (ALLOY 24345) FOR AEROSPACE APPLICATIONS — SPECIFICATION ( *First Revision* )

### 1 SCOPE

This standard covers the requirements of aluminium - copper - magnesium - silicon - manganese alloy (Alloy 24345) forging stocks (billets, bars, rods, sections) and forgings. The material is intended primarily for aircraft structural parts requiring moderate strength.

### 2 REFERENCES

The following Indian Standards contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

| <i>IS No.</i>       | <i>Title</i>   |
|---------------------|--|
| 23 : 1980           | Primary aluminium ingots for remelting for aircraft purposes ( <i>third revision</i> )                                       |
| 504 : 1963          | Methods of chemical analysis of aluminium and its alloys ( <i>revised</i> )  |
| 1500 : 1983         | Method for Brinell hardness test for metallic materials ( <i>second revision</i> )   |
| 1608 : 1995         | Mechanical testing of metals — Tensile testing ( <i>second revision</i> )  |
| 3658 : 1999         | Code of practice for liquid penetrant flaw detection ( <i>second revision</i> )  |
| 3664 : 1981         | Code of practice for ultrasonic pulse echo testing by contact and immersion methods ( <i>first revision</i> )                |
| 5047(Part 1) : 1986 | Glossary of terms relating to aluminium and aluminium alloys: Part 1 Unwrought and wrought metals ( <i>second revision</i> ) |
| 7674 : 1975         | Procedure for inspection and testing of aluminium and aluminium alloy forging stock and forgings for aircraft purposes       |
| 10259 : 1982        | General conditions for delivery and inspection of aluminium and aluminium alloy products                                     |

### 3 TERMINOLOGY

**3.1** For the purpose of this standard the definitions as given in IS 5047 (Part 1), IS 7674 and the following shall apply.

#### 3.1.1 *Approved Scrap*

The scrap which is derived from manufacturer's own production from approved material, ingots and castings etc, where in the material composition has been established with regard to both alloying elements and impurities to the relevant specification segregated and identified to the satisfaction of inspecting authority.

#### 3.1.2 *Cast (Melt)*

The product of either one furnace melt, or a number of furnace melts where such are aggregated and mixed prior to sampling or pouring.

#### 3.1.3 *Extrusion Billet*

A solid or hollow cast billet for extrusion to solid or hollow shapes and sections.

#### 3.1.4 *Harmful Defects*

Any defect prejudicial to subsequent manufacture, fabrication or any use of material.

#### 3.1.5 *Work's Analysis*

The routine analysis carried out by the manufacturer in order to control the quality of the material.

### 4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall conform to IS 10259.

### 5 MANUFACTURE

The alloy made from primary or virgin aluminium shall comply to the requirements of IS 23. Unless otherwise agreed to, the selection of alloying elements, whether it is approved scrap or not, shall be left to the discretion of the manufacturer.

### 6 FREEDOM FROM DEFECTS

Forging stock and forgings shall be of uniform quality, sound and free from harmful defects.

## 7 CHEMICAL COMPOSITION

The material when analyzed as per IS 504 or any other established instrumental/chemical method shall conform to the requirements as given in Table 1. In case of dispute, the procedure given in IS 504 shall be the referee method. However when the method is not given in IS 504 the referee method shall be as agreed to between the purchaser and the manufacturer.

**Table 1 Chemical Composition**  
(Clause 7)

| Element            | Percent |           |
|--------------------|---------|-----------|
|                    | Min     | Max       |
| (1)                | (2)     | (3)       |
| Copper             | 3.9     | 5.0       |
| Magnesium          | 0.2     | 0.8       |
| Silicon            | 0.5     | 0.9       |
| Manganese          | 0.4     | 1.2       |
| Titanium           | —       | 0.15      |
| Titanium+Zirconium | —       | 0.2       |
| Iron               | —       | 0.5       |
| Zinc               | —       | 0.2       |
| Tin                | —       | 0.05      |
| Chromium           | —       | 0.1       |
| Nickel             | —       | 0.2       |
| Lead               | —       | 0.05      |
| Others:            |         |           |
| Each               | —       | 0.05      |
| Total              | —       | 0.15      |
| Aluminium          |         | Remainder |

## 8 CONDITION OF SUPPLY

### 8.1 Forging Stocks

Unless otherwise stated in the drawing or purchase order, the forging stocks shall be straightened and supplied in 'as manufactured' condition (M).

### 8.2 Forgings

Unless otherwise stated in the drawing or purchase order, forgings shall be supplied in solution treated and precipitation treated condition (T6).

## 9 HEAT TREATMENT

9.1 Unless otherwise stated in the drawing or purchaser order, the forging stock and forgings shall be heat treated as under:

- Solution treatment by heating at a temperature of  $500 \pm 5^\circ\text{C}$ , soak for sufficient time and quench in water at  $40-70^\circ\text{C}$ ,

NOTE — Quenching in solution treatment may be carried out at temperature higher than  $70^\circ\text{C}$ , if agreed to between the purchaser and manufacturer.

- Precipitation treatment at a temperature  $160-$

$190^\circ\text{C}$  followed by cooling in air. Temperature and duration which have been found appropriate are as given below:

| Temperature<br>in $^\circ\text{C}$ | Duration<br>in h |
|------------------------------------|------------------|
| 160                                | 12 - 20          |
| 175                                | 9 - 12           |
| 190                                | 3 - 6            |

9.2 Unless otherwise agreed to between the purchaser and manufacturer, the heat treatment (solution treatment and precipitation treatment) is limited to maximum two heat treatment cycles.

9.3 If forgings are to be heat treated by the purchaser, the manufacturer shall supply along with the forgings, representative test samples together with details of heat treatment cycle.

NOTE — If time delay is necessary to accommodate operations like straightening, cold compression and levelling etc, the quenched parts shall be refrigerated at  $-5$  to  $-15^\circ\text{C}$  up to 48 h. However, operation is to be completed within 2 hours of removing from cold storage and attaining room temperature.

## 10 MECHANICAL PROPERTIES

### 10.1 Tensile Test

10.1.1 The tensile test is to be carried out as per IS 1608 on the heat treated forged bar/forging stock test specimens prepared in accordance with relevant clauses of IS 7674, shall conform to the values given in Table 2.

10.1.2 Unless otherwise agreed to, the test specimen shall be taken in the longitudinal direction or along the grain shall conform to the values given in Table 2.

10.1.3 Unless otherwise agreed to, mechanical properties obtained from test specimens taken in directions other than longitudinal in the case of forgings are given in Table 3.

### 10.2 Hardness

10.2.1 The Brinell hardness test shall be carried out as per IS 1500 on forgings and forged test pieces (using  $P/D^2 = 10$ ).

10.2.2 The hardness of forging stock and forgings, heat treated as per 9 shall not be less than 134 HB or as agreed to between the purchaser and the manufacturer.

## 11 DIMENSIONS AND TOLERANCES

11.1 Dimensions of the forging stock and forgings shall be as agreed to between the purchaser and the manufacture.

11.2 Unless otherwise agreed to between the purchaser and the manufacturer, tolerances on the dimensions

**Table 2 Mechanical Properties**  
(Clauses 10.1.1 and 10.1.2)

| Material Represented   | Test Sample Prepared by | Diameter or Minor Sectional Dimensions of Forging Stock |                         | 0.2 Percent Proof Stress, <i>Min</i><br>MPa | Tensile Strength, <i>Min</i><br>MPa | Elongation, <i>Min</i> on Gauge Length |                             |
|--|-------------------------|---|-------------------------|---|-------------------------------------|--|-----------------------------|
|  |                         | Over<br>mm  | Up to & including<br>mm |   |                                     | 50 mm<br>percent                       | $5.65\sqrt{S_0}$<br>percent |
| (1)  | (2)                     | (3)   | (4)                     | (5)   | (6)                                 | (7)                                    | (8)                         |
| Extruded forging from extruded stock   | Machining               | 0   | 10                      | 380   | 430                                 | 6                                      | —                           |
|  |                         | 10  | 20                      | 400   | 430                                 | 6                                      | 6                           |
|  |                         | 20  | 75                      | 420   | 460                                 | —                                      | 6                           |
|  |                         | 75  | 150                     | 390   | 430                                 | —                                      | 5                           |
|  |                         | 150   | 200                     | 350   | 400                                 | —                                      | 5                           |
| Extruded forging stock, forging made from:<br>Cast Billets<br>Hot Rolled plate<br>Extruded Stock | Forging                 | All sizes   |                         | 395   | 450                                 | 6                                      | 6                           |

**Table 3 Mechanical Properties**  
(Clause 10.1.3)  
(For information only)

| Dimensions of Forging<br>Dia/Thickness |                   | 0.2% Proof Stress | Tensile Strength | % Elongation on Gauge Length $5.65\sqrt{S_0}$ |
|--|-------------------|-------------------|------------------|---|
| Over                                   | Up to & including | <i>Min</i>        | <i>Min</i>       | <i>Min</i>                                    |
| mm                                     | mm                | MPa               | MPa              |   |
| (1)                                    | (2)               | (3)               | (4)              | (5)   |
| 0                                      | 100               | 370               | 435              | 3   |
| 100                                    | 200 <sup>1)</sup> | 350               | 395              | 3   |

<sup>1)</sup>Generally hand forgings.

NOTE — In case hot water quench (exceeding 70°C) is used in solution treatment, strength values could be lower.

of the forging stock and forgings shall conform to the requirements of IS 7674.

## 12 QUALITY ASSURANCE

### 12.1 Inspection and Testing

12.1.1 The purchaser shall be given full opportunity to inspect/test the material at any time/stage of manufacture.

12.1.2 The forging stock and forgings shall be inspected and tested as per the requirements given in the IS 7674.

12.1.3 The manufacturer shall supply a copy of work's analysis, if desired by the purchaser.

### 12.2 Special Tests

#### 12.2.1 Ultrasonic and Dye Penetrant Tests

If so desired by the purchaser, ultrasonic test as per

IS 3664 and dye penetrant test as per IS 3658 shall be carried out on the forging stock and forgings, to ensure that the material is free from harmful defects.

#### 12.2.2 Macro and Micro-Examination

If so desired by the purchaser, macro and micro examination shall be carried on the samples selected. Grain flow pattern on macro etched sections of the forgings shall conform to those indicated on the drawing/test sheet or as agreed to. The micro examination shall reveal satisfactory structure, free from inclusions and heterogeneity etc.

## 13 RETEST

13.1 In the case of failure of the material in any test, acceptance/rejection shall be based on the results of retests conducted as per IS 7674.

13.2 Any material can be rejected for faults in

manufacture although it may have passed chemical and mechanical tests.

**13.3** Forging stock and forgings shall conform to dimensions and tolerances, chemical composition, mechanical properties and hardness requirements. Forging stock and forgings not meeting the requirement shall be rejected.

#### **14 TEST CERTIFICATE**

All supplies shall be accompanied by the certificates for freedom from defects, non-destructive tests, chemical composition, heat treatment carried out if any, mechanical properties, hardness as laid down in the relevant clauses of this standard or as required by the drawing or test sheet.

#### **15 PACKING**

The forging stock and forgings shall be packed in such a manner so as to prevent damage in ordinary handling and transportation. Unless otherwise mentioned in

order, the type of packing and gross weight of individual package will be left to the discretion of the supplier. Each package shall contain only one size, alloy or temper material when packed for dispatch. Unless otherwise agreed upon.

#### **16 MARKING**

**16.1** Unless otherwise agreed upon or mentioned in the purchase order, each package shall be marked with the details as given in IS 7674.

**16.1.1** The material may also be marked with the Standard Mark.

**16.1.2** The use of Standard Mark is governed by the provision of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made there under. The details of the conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc : No. MTD 7 (4064).

**Amendments Issued Since Publication**

| Amend No. | Date of Issue | Text Affected |
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